201-14950

HIGH PRODUCTION VOLUME (HPV) CHALLENGE PROGRAM

TEST PLAN

AND ROBUST SUMMARIES

FOR

POLYPHOSPHORIC ACID ESTERS OF TRIETHANOLAMINE, SODIUM SALTS

CAS NO. – 68131-72-6

PREPARED BY:

ARCH CHEMICALS, INC.

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TABLE OF CONTENTS

OVERVIEW

Arch Chemicals, Inc. (Arch) hereby submits the test plan and robust summaries for polyphosphoric acid esters of triethanolamine, sodium salts (CASRN – 68131-72-6) under the Environmental Protection Agency's High Production Volume Chemical Challenge Program. It is the intent of Arch to use existing data for triethanolamine (CASRN – 102-71-6) to adequately fulfill the Screening Information Data Set (SIDS) for the physical/chemical endpoints, environmental fate, ecotoxicity and human health-related toxicology.

Polyphosphoric acid esters with triethanolamine is an amber liquid having a very mild ammonia odor. This chemical is an aqueous surfactant solution containing a partially neutralized mixture of triethanolamine polyphosphoric acid esters used to impart corrosion and scale inhibition properties to water recirculating systems such as air conditioning cooling tower, secondary oil recovery operations, boiler equipment, and other water treatment applications where scale build-up can be a problem.
The pH of a 5 % solution in neutral distilled water is in the range of 4-6.

The average composition of the final product can be calculated from the result of (a) direct analysis of the product for orthophosphate, which is a direct measure of the amount of sodium dihydrogen phosphate byproduct formed by competitive reactions, (b) direct analysis of the product for total solids and (c) a knowledge of the amounts of raw materials charged at the beginning of the reaction. Specifications for this chemical are 70% minimum total solids and 20% maximum orthophosphate. At these limits, the average product composition calculates to be a mixture of diester and monoester in a mole ratio of about 3:2. As orthophosphate goes down (but total solids stay the same) this ratio gets larger, i.e. there is more diester and less monoester, until at an orthophosphate level of 12.2%, the product is all diester. Typical total solids are 70-72% and the typical orthophosphate level is 14-18%. The actual product composition, due to the statistical randomness of the competitive hydrolysis reactions, will vary somewhat from this theoretical average and will probably include small amounts of both triester and free triethanolamine.

JUSTIFICATION FOR USE OF TRIETHANOLAMINE AS A SURROGATE FOR POLYPHOSPHORIC ACID ESTERS OF TRIETHANOLAMINE

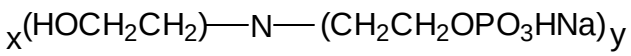
Polyphosphoric acid esters with triethanolamine, sodium salts is manufactured as an aqueous solution from polyphosphoric acid, triethanolamine and sodium hydroxide. This material is a mixture of tri-, di-, and monophosphate esters of triethanolamine and consequently is classified with a range of molecular weight. Thus, the molecular weight ranges from 251 for the sodium salt of the monophosphate ester to 455 for the sodium salt of the triphosphate ester. The molecular weight for triethanolamine is 149. The difference in molecular weight is due to the varying amount sodium and phosphate groups. Triethanolamine is a pale yellow hygroscopic viscous liquid with a melting point of 21^{o}C. It has a vapor pressure of <0.01 mm Hg at 20^{o}C (Howard, 1990). Both triethanolamine (Howard, 1990) and polyphosphoric acid esters with triethanolamine,

sodium salts are miscible with water. The molecular structure of the two chemicals is similar. In the synthesis of polyphosphoric acid esters with triethanolamine, sodium salts the structure of triethanolamine is modified only by the presence of a phosphate group with sodium at the end of one or more of the ethanol groups.

The presence of phosphate groups esterified with triethanolamine would probably facilitate the excretion of this material from the body. The phosphate groups would not increase the toxicity of triethanolamine and, in all likelihood, would decrease it to both mammals and aquatic organisms. Metabolically, polyphosphoric acid esters with triethanolamine, sodium salts could undergo hydrolysis resulting in removal of one or more phosphate groups from triethanolamine. The phosphate groups would then be available to enter the general phosphate pool of the body. The toxicity of phosphate is low and in fact, phosphate is critical to normal physiological function of the body. Removal of all the phosphate groups results in triethanolamine, the chemical that will serve as the surrogate to define the physical/chemical properties, environmental fate, aquatic toxicity and mammalian toxicity of polyphosphoric acid esters with triethanolamine, sodium salts.

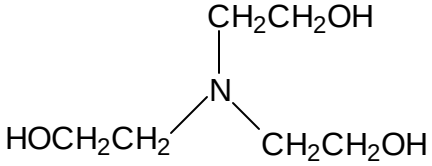
Comparison of the chemical structure between polyphosphoric acid esters with triethanolamine, sodium salts and triethanolamine

- **Polyphosphoric acid esters with triethanolamine, sodium salts**



Where
x = 1 - 2
y = 1 - 2

- **Triethanolamine**



TEST PLAN SUMMARY

Polyphosphoric acid esters with triethanolamine, sodium salts CAS # 68131-72-6	Information	OECD Study	Other	Estimation	GLP	Acceptable	New Testing Required
STUDY	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N
PHYSICAL-CHEMICAL DATA							
Melting Point	Y	N	Y	N	N	Y	N
Boiling Point	Y	N	Y	N	N	Y	N
Vapor Pressure	Y	N	Y	N	N	Y	N
Partition Coefficient	Y	N	Y	N	N	Y	N
Water Solubility	Y	N	Y	N	N	Y	N
ENVIRONMENTAL FATE DATA							
Photodegradation	Y	N	Y	N	N	Y	N
Stability in Water	N	N	Y	Y	N	Y	N
Biodegradation	Y	N	Y	N	N	Y	N
Transport between Environmental Compartments (Fugacity)	Y	N	Y	Y	N	Y	N
ECOTOXICOLOGICAL DATA							
Acute Toxicity to Fish	Y	N	Y	N	N	Y	N
Acute Toxicity to Aquatic Invertebrates	Y	N	Y	N	N	Y	N
Toxicity to Aquatic Plants	Y	N	Y	N	N	Y	N
MAMMALIAN TOXICOLOGICAL DATA							
Acute Toxicity	Y	N	Y	N	N	Y	N
Repeated Dose Toxicity	Y	N	Y	N	N	Y	N
Genetic Toxicity							
Mutation	Y	N	Y	N	N	Y	N
Chromosomal Aberration	Y	N	Y	N	N	Y	N
Developmental Toxicity	Y	N	Y	N	N	Y	N
Toxicity to Reproduction	N	N	Y	Y	N	Y	N

TEST PLAN DESCRIPTION FOR EACH SIDS ENDPOINT

A. Physical/Chemical Endpoints for Triethanolamine

Melting Point – A value for this endpoint was obtained from a standard reference text (Howard, 1990).

Boiling Point – A value for this endpoint was obtained from a standard reference text (Howard, 1990).

Vapor Pressure – A value for this endpoint was obtained from a standard reference text (Howard, 1990).

Partition Coefficient – Values for this endpoint were obtained from company data (BASF, 1989 and 1991) and a standard reference text (Howard, 1990).

Water Solubility – A value for this endpoint was obtained from a standard reference text (Howard, 1990).

Conclusion – All endpoints have been satisfied by the utilization of data obtained from a reliable reference text or company data. Thus, no new testing is needed in the area of physical/chemical properties.

B. Environmental Fate Endpoints for Triethanolamine

Photodegradation – A value for this endpoint was obtained from a standard reference text (Howard, 1990) and from a computer estimation model (AopWin v.1.90, 2000).

Stability in Water – If released to water, triethanolamine should biodegrade. The half-life of this compound is expected to range from a few days to a few weeks depending on the degree of acclimation of the system. Bioconcentration in aquatic organisms, adsorption to suspended solids and sediments, and volatilization are not expected to be important fate processes in water. Triethanolamine does not decompose or hydrolyze in contact with water and there is no abiotic degradation (Howard, 1990).

Biodegradation – This endpoint was satisfied using data from studies published in the open literature (Gerike and Fischer, 1979; Zahn and Wellens, 1980). The data indicate that triethanolamine is inherently biodegradable. In the ready biodegradation tests, triethanolamine was readily biodegradable in the AFNOR (97% degradation based on DOC removal), STURM (91% degradation based on CO_2 evolution) and OECD Screening test (96% degradation based on DOC removal, but little degradation was observed in the MITI (14 day test; 2% removal based on BOD and Closed Bottle (0-9% removal based on BOD) (SIDS Initial Assessment Report). The SIDS Initial Assessment Report concluded that triethanolamine is readily biodegradable, possibly after a short acclimation period

and that extensive removal due to biodegradation is to be expected in sewage treatment plants.

Fugacity – This endpoint was satisfied using data from intracompany correspondence (Comber, 1993. ICI Chemicals). Due to the high water solubility and low vapor pressure of triethanolamine, it is likely to partition preferentially into the water phase from which volatilization to the atmosphere is likely to be only a minor removal process. The low log Kow value indicates that bioaccumulation and adsorption onto soils/sediments is unlikely to occur.

Conclusion – All endpoints have been satisfied using actual data, through the use of EPA-acceptable estimation models, a standard reference text, or, in the case of stability in water, scientific judgment to support the position for testing requirements. No additional testing is needed in the area of environmental fate.

C. Ecotoxicity Endpoints for Triethanolamine

Acute Toxicity to Fish – This endpoint was satisfied using data from aquatic toxicity studies published in the open literature (Birdie et al., 1979; Geiger et al., 1987). Two freshwater species were used – *Carassius auratus and Pimelphales promelas*. The LC_{50} (24 to 48-hour exposure) was greater than 1000 mg/l to both species.

Acute Toxicity to Aquatic Invertebrates – This endpoint was satisfied using data from aquatic toxicity studies published in the open literature (Bringman and Kuhn, 1982; Bringman and Kuhn, 1987). The test species was *Daphnia magna*. The EC_{50} (24-hour exposure) was greater than 1000 mg/l.

Toxicity to Aquatic Plants – This endpoint was satisfied using data from aquatic toxicity studies published in the open literature (Amann and Stainhauser, 1986; Kuhn and Pattard, 1990). The test species was *Scenedesmus subspicatus*. The EC_{50} (72 to 96-hour exposure) ranged from 169 to 910 mg/l. The difference was dependent upon the pH with the non-neutralized triethanolamine exerting the greater toxicity.

Conclusion – All endpoints have been satisfied using actual data from literature sources. No additional testing is needed in the area of environmental fate.

D. Mammalian Toxicological Endpoints for Triethanolamine

Acute Toxicity – The studies that satisfy this endpoint were conducted prior to introduction of GLP. However, all studies (Oral LD_{50}, dermal LD_{50} and inhalation LC_{50}) to define the acute toxicological profile were conducted in accordance with currently accepted scientific principles and are considered reliable. The data indicate that triethanolamine is of low toxicity by the oral, dermal and inhalation routes of exposure. Oral LD_{50} values have been shown to

range from approximately 5-10 g/kg (Smyth et al., 1951; Kindsvatter, 1940; Cosmetic Ingredient Review, 1983). The dermal LD_{50} is greater than 2 g/kg (Cosmetic Ingredient Review, 1983). The inhalation LC_{50} is greater than a saturated atmosphere (BASF AG, 1966)

Repeat Dose Toxicity – The studies to determine toxicity of triethanolamine from repeated exposure were conducted for a duration of 91 days (CTFA, 1976) or 2 years (Maekawa et al., 1986). In both studies the NOAEL was at least 1000 mg/kg. There was no evidence of gross or histopathological change that could be attributed to treatment. Also, triethanolamine was shown to be non-carcinogenic.

Genetic Toxicity

Mutation (bacterial) – This endpoint has been satisfied by two studies (Inoue et al., 1982; Mortelmans et al., 1986) using 4 strains (TA 98, TA 100, TA 1535 and TA 1537) of *Salmonella typhimurium*. Triethanolamine was not mutagenic in any of the tester strains.

Chromosomal aberration (mammalian, *in vitro*) – This endpoint was satisfied by a cytogenetic assay using Chinese hamster lung cells (Inoue et al., 1982). Triethanolamine did not induce chromosome aberrations in this test system.

Reproductive Toxicity – No studies have been conducted to specifically evaluate the effect of triethanolamine on reproductive performance. However, based on consideration of the repeat dose toxicity studies of at least 90 days duration, there were no abnormalities noted in the histopathological examination of reproductive organs. This fact, and the lack of effects on fetal development, allow the conclusion that triethanolamine would not be expected to produce adverse effects to reproductive performance and fertility.

Developmental Toxicity – This endpoint was satisfied using a developmental toxicity screening study according to the Chernoff-Kavlock method (Pereira et al., 1987). Based on the results from this test, triethanolamine does not impair development of the fetus.

Conclusion – The endpoints for acute toxicity and genetic toxicity have been satisfied with data from studies that were conducted utilizing methods that are similar to established guidelines and are scientifically appropriate. The endpoints of repeat dose toxicity, reproductive toxicity and developmental toxicity have not been satisfied. Studies will be conducted to supply data for these endpoints and they will be conducted according to OECD guidelines and GLP assurances.

SIDS DATA SUMMARY

Triethanolamine is a high boiling liquid that is miscible with water. It has a low vapor pressure and a low log K_{ow}. Due to the high water solubility and low vapor pressure, triethanolamine is likely to partition preferentially into the water phase from which volatilization to the atmosphere is likely to be only a minor removal process. The low log K_{ow} indicates that bioaccumulation and adsorption onto soils/sediment is unlikely to occur. Triethanolamine is readily biodegradable.

The ecotoxicity of triethanolamine is low regardless of the test organism. Fish exhibit the least sensitivity to this chemical with 96-hour LC_{50} values in the range of 5,000-10,000 mg/l. The toxicity to the water flea is also low with the 24-hour EC_{50} greater than 1,000 mg/l. Algae show the greatest sensitivity, but even so the 96-hour EC_{50} is almost 1,000 mg/l for neutralized triethanolamine.

Triethanolamine is of low toxicity following single exposures. It is not genotoxic or carcinogenic. It does not impair development of the fetus and does not produce toxicity to the reproductive system. Also, it is judged not to impair reproductive performance or fertility based on its lack of developmental toxicity and histopathological change to the reproductive organs.

The physical/chemical properties, environmental fate and aquatic and mammalian toxicological data for triethanolamine have been reviewed by the OECD High Production Volume Chemicals Program through a SIDS Initial Assessment Report (SIAR). Based on the evaluation of all the data presented in the SIAR, triethanolamine is presently considered of low priority for further work and moreover, no further toxicity testing is required.

The presence of esterified phosphate groups on triethanolamine is judged not to significantly alter the above characteristics of physical/chemical properties, environmental fate and aquatic and mammalian toxicity. Thus, it is the judgment of Arch Chemicals, Inc. that triethanolamine is an appropriate analog for use to predict the chemical/physical properties, environmental fate and aquatic and mammalian toxicity of polyphosphoric acid esters of triethanolamine, sodium salts (CASRN 68131-72-6).

The SIDS Initial Assessment Report concluded that triethanolamine is presently of low priority for further work and that no further toxicity testing is required.

EVALUATION OF DATA FOR QUALITY AND ACCEPTABILITY

The collected data were reviewed for quality and acceptability following the systematic approach described by Klimisch et al. (1997). The codification described by Klimisch specifies four categories of reliability for describing data adequacy. They are:

1. Reliable without restriction: Includes studies or data complying with Good Laboratory Practices (GLP) procedures, or with valid and/or internationally accepted testing guidelines, or in which the test parameters are documented and comparable to these guidelines.

2. Reliable with restrictions: Includes studies or data in which test parameters are documented but vary slightly from testing guidelines.

3. Not reliable: Includes studies or data in which there are interferences, or that use non-relevant organisms or exposure routes, or which were carried out using unacceptable methods, or where documentation is insufficient.

4. Not assignable: Includes studies or data in which insufficient detail is reported to assign a rating, e.g., listed in abstracts or secondary literature.

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